

# Vibration Test Facility

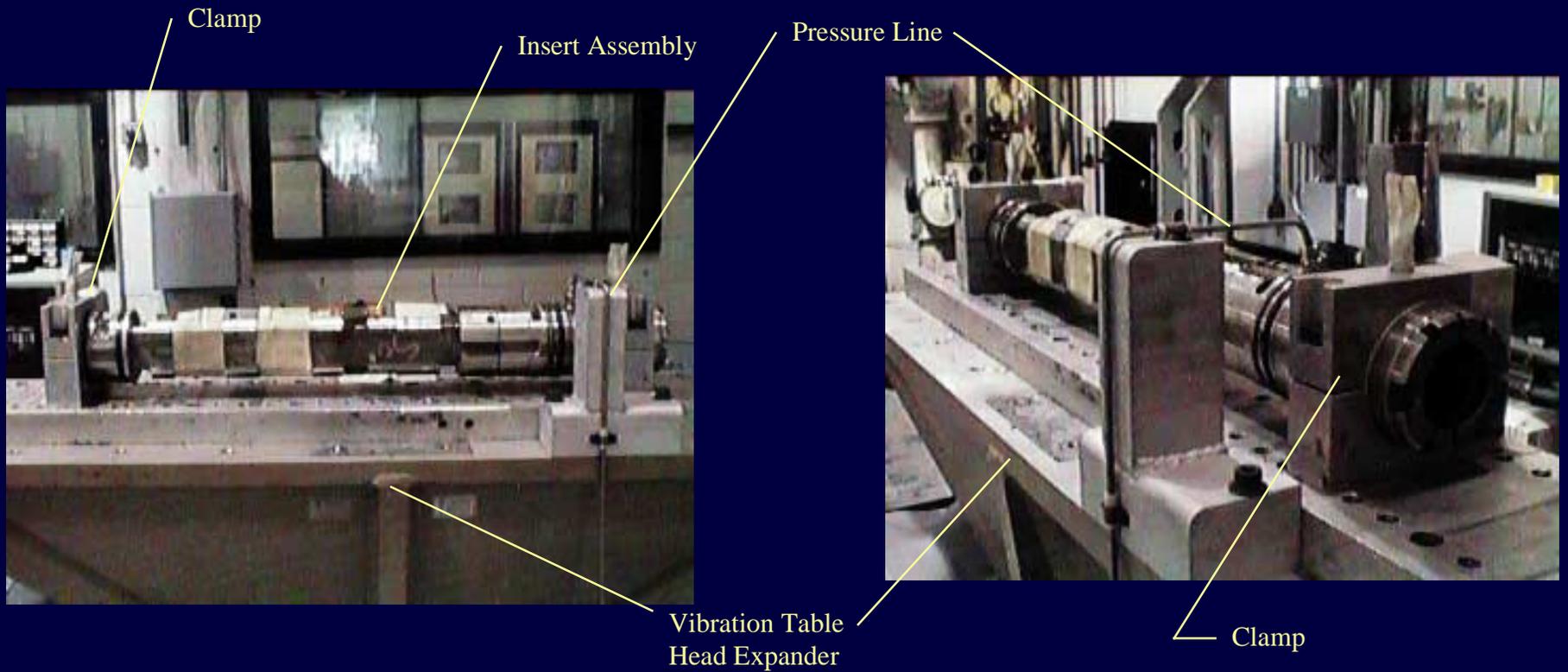


**Vertical Vibration Table**

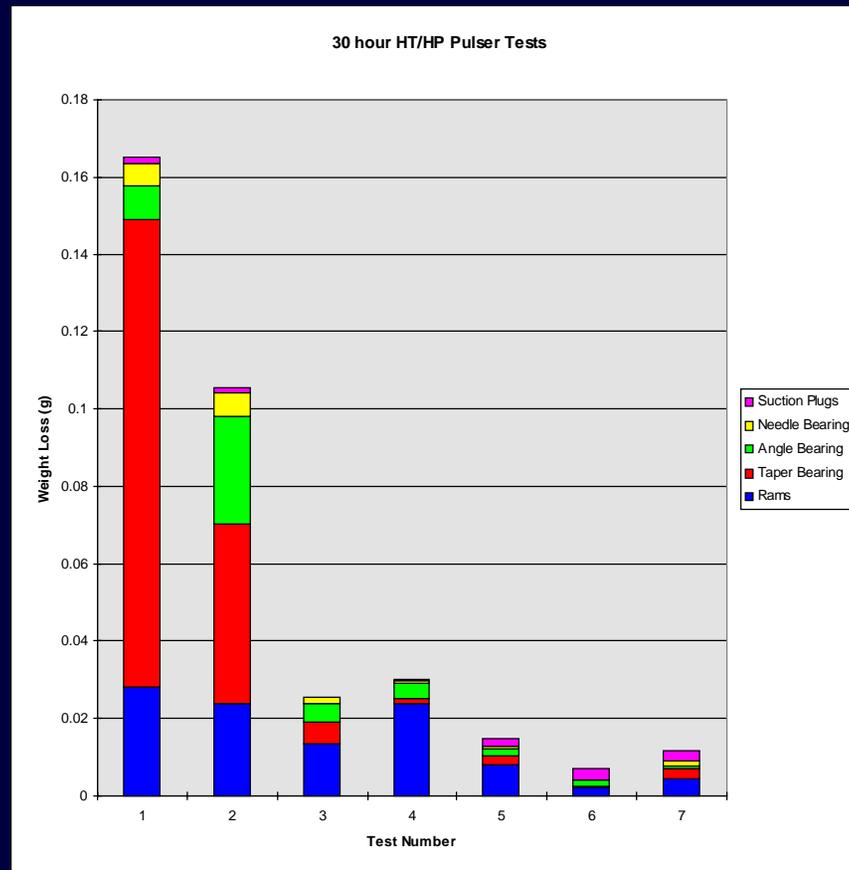


**Horizontal Vibration Table**

# Typical Vibration Test Setup



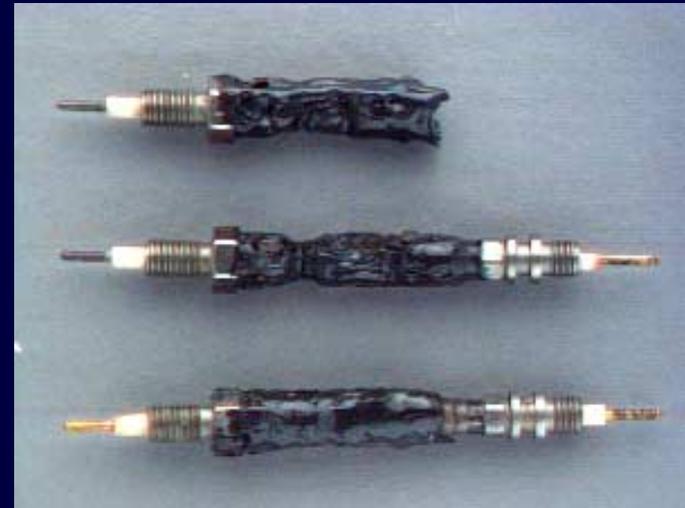
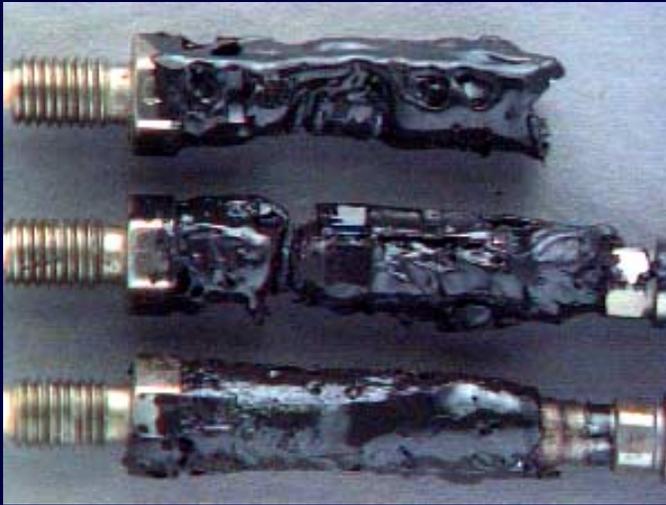
# Reduction in Internal Pulser Wear as Improvements were Implemented



# Connectors Before Thermal Exposure



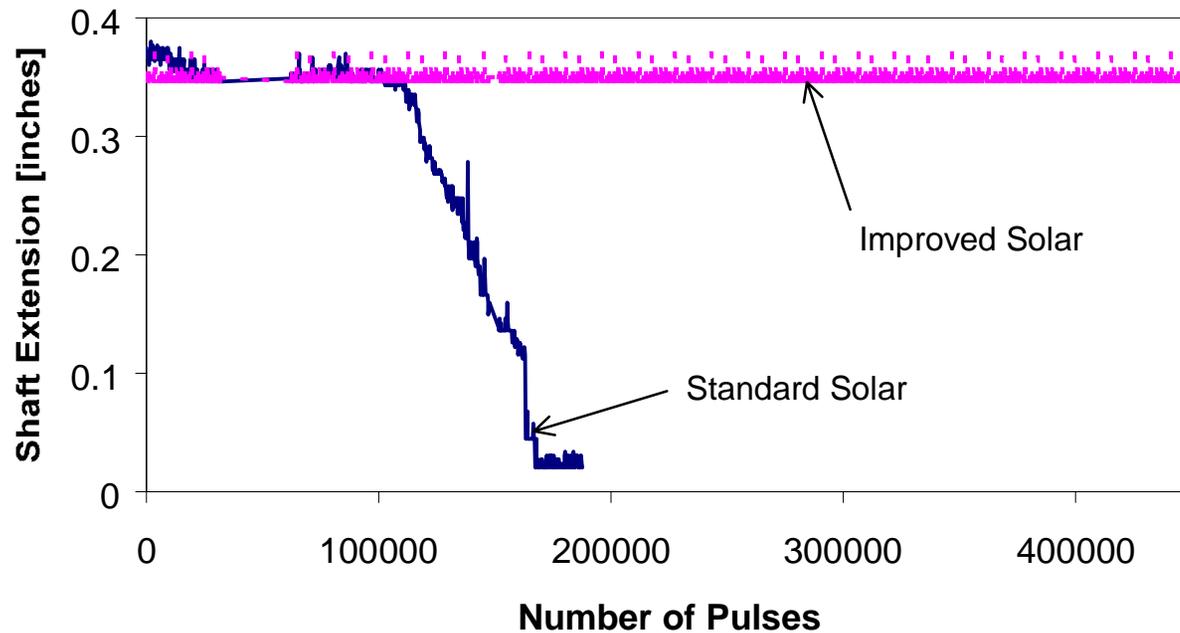
# Connectors After Thermal Exposure



- High Temperature Exposure of electrical connectors in a saturated steam environment caused severe degradation of the Viton rubber. This was demonstrated and an alternate material was selected by closed-cavity testing.

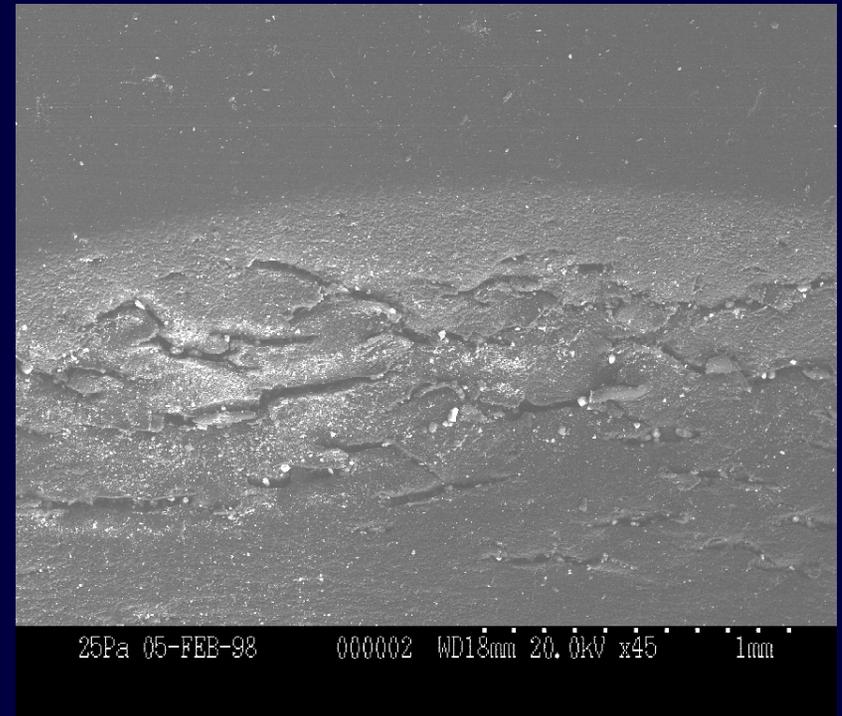
# Pulser Poppet Shaft Extension is Reduced by Wear Debris in Control Valve

Poppet Shaft Extension Vs. Number of Pulses



100,000 cycles = 35 hours

# Poppet Shaft wear and Rubber Boot Damage Commonly Observed with Boot Design

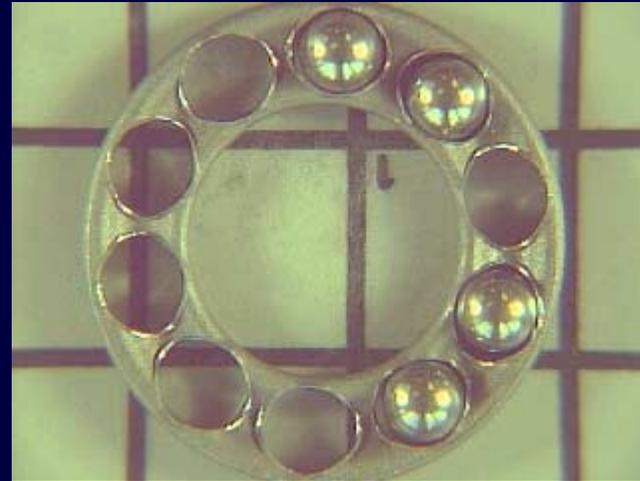


# Tapered Roller Bearing

- Top image is with latest design improvements after 207 hours of HT/HP testing
- Bottom image shows severe galling damage to original design after 29 hours of HT/HP testing



# Angle Plate Bearings and Race



- Original design with stamped cage, and standard bearing ball and race materials after 29 hours of HT/HP testing

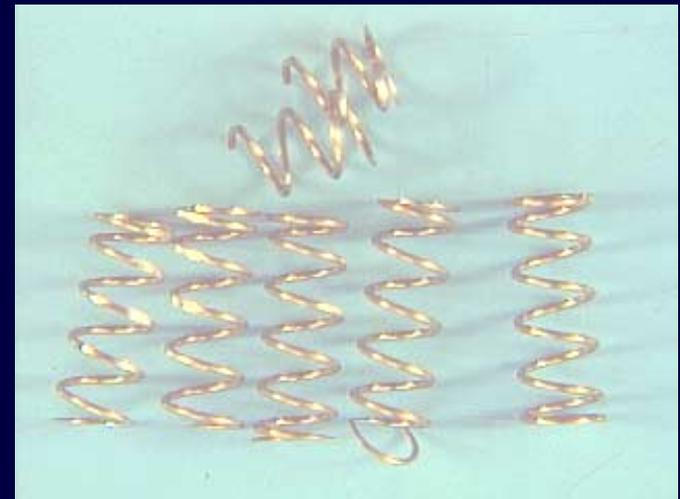
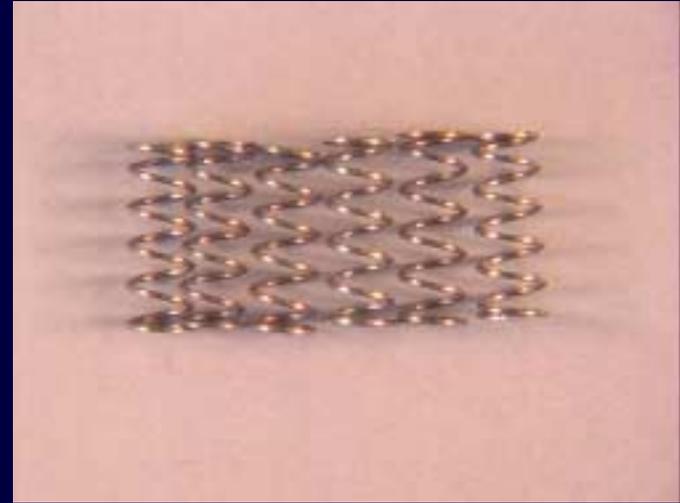
# Angle Plate Bearings and Race



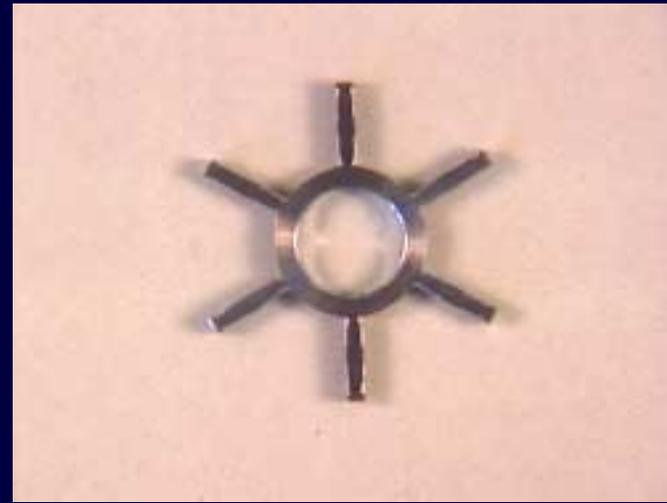
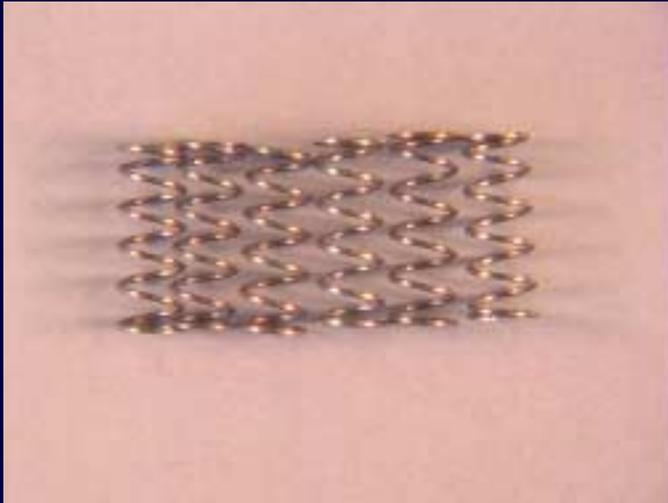
- Latest Design with machined cage, silicon nitride balls, and M50 races after 207 hours of HT/HP testing

# Positive Displacement Pump Piston Return Springs

- Top image shows springs after 207 hours of HT/HP testing with latest design improvements
- Bottom image shows worn and broken springs from a earlier design after HT/HP testing



# Positive Displacement Pump Piston Return Springs



- Springs and Piston Anti-rotation spider after 207 hours of HT/HP testing with latest design improvements